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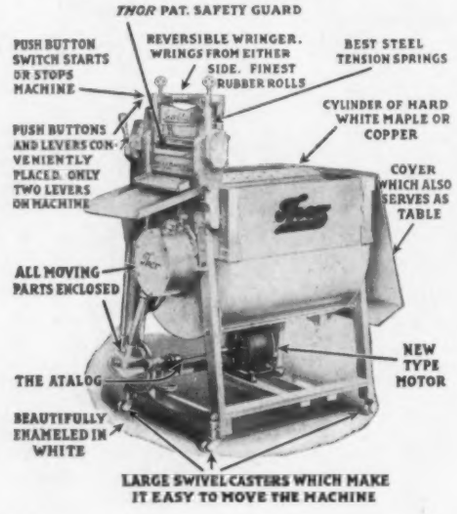
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DEVELOPING ELECTRIC RANGE AND HEATING BUSINESS

BY E. A. WILCOX.

The introduction of electric ranges in the territory served by the Great Western Power Company of California has been carried on quietly but effectively by its sales department during the past twelve months. No special sales campaign was instituted when the work of placing ranges in the consumer's homes was undertaken. The regular members of the sales force were supplied with general information on electric cooking, asked to familiarize themselves with it, and instructed how to sell ranges.

San Francisco Electric Range Display Rooms of Great Western Power Co.

The results of the effort so far expended have been very satisfactory. Whereas there were less than 20 ranges in satisfactory operation on the entire system a year ago there are now over 400 ranges in successful service. Furthermore, a corps of salesmen has been trained to know the best methods of selling ranges and the interest of the men in every department has been created and their confidence established in the substantial nature of the business.

Reviewing the progress that has been made and the manner in which the work was undertaken, it is apparent that effort has been well directed. Had an elaborate and expensive campaign been instituted a year ago many mistakes might have been made, inaccurate advice given, and less efficient service rendered than is possible with the trained salesmen and service men now engaged in the work. At the present time confidence in and knowledge of electric cooking is apparent among all the employes and the salesmen have lists of many satisfied customers and records of energy consumption to which prospective users may be referred.

Profiting by its experience and the advantages gained during the past year, the Great Western Power Company has decided upon the expenditure of certain sums and the establishment of a general policy for promoting the sale of ranges during the ensuing season. As in other matters pertaining to the management and general policy of the company, W. W. Briggs, general agent, is directing the activities of the range department and giving it his careful thought and attention. A mark has been set by Mr. Briggs for the sale of 1400 ranges during the six months' period succeeding May 1, 1916, and present indications are that this figure may even be exceeded.

The development of the range business has naturally expanded into the sale of water heaters, bake ovens, and various industrial heating and cooking devices. Approximately 160 water heaters are now in use on the company's lines. Eight electric bake ovens of various sizes have been placed in service in cafeterias and small bakeries. A new 500 loaf oven, one of the largest ever manufactured, is being installed in Sacramento. The electric cafeteria in Sacramento, which operates entirely by electricity and has a connected load of 119 kw., is another industrial application re-

sulting from interest created by the development of the domestic range business. Other industrial heating installations, including enameling furnaces, drying ovens, welding machines, metal melting pots, etc., are being installed.

In line with the present active effort being put forth on the introduction of electric ranges, water heaters and other heating devices, display rooms have been opened in several of the districts. As the central offices of the company in San Francisco were found to be of too small capacity to afford adequate display room facilities, quarters were finally secured near one of the prominent corners in the city's downtown shopping district. These new quarters, consisting of a first and second floor in the Press Club building, have been elegantly fitted up and are probably as completely equipped as any power company's sales rooms in the country, utilized exclusively for electric ranges and heating device displays.

The main portion of the new display rooms, or exposition quarters, as they would be more appropriately named, is on the second floor and is reached by a stairway or an elevator. On this floor practically all the modern makes of electric ranges in various styles are on exhibition. The space provided is 80 ft. long and 20 ft. wide. The polished floors, light colored walls and ceilings, large windows, semi-indirect lighting fixtures and modern furnishings combine to make the room exceedingly attractive. Heavy baseboard plugs are arranged around the room to permit the connecting and demonstrating of ranges as desired. A complete electric kitchen has been fitted up in one corner to show the housewife how her own home workshop would appear with modern convenient labor saving devices installed. Other portions of the room are provided with tables, chairs and rugs so as to present the appearance of a rest room. Full sets of dishes are available and it is planned to serve tea during the afternoons. Miss Elizabeth Holmes is in charge of the display room and acts as hostess to the visitors.

The front part of the first floor is arranged for display purposes and the back portion for office space. The display window has been fitted up especially for exhibiting ranges and attracting prospective purchasers. Flood lights are mounted above the window. The arrangement and trimmings are changed and different makes and styles of ranges placed in the window regularly.

Of particular interest is a model electric water-heater which has been installed in an out-of-the-way corner of the electric kitchen. This equipment consists of an ordinary 30 gallon kitchen boiler which has been converted to the most efficient type of electric water-heater by merely removing the side and bottom water-back connections and respectively inserting a specially designed thermostat and a 1500-watt heating element. To complete this simple conversion, a standard hair-felt boiler cover is laced around the tank, covering it top and bottom, which conserves the stored heat and holds available for use at any hour of the day or night 30 gallons of water heated to the temperature at which the thermostat is adjusted to operate.

To check in detail the operation of this water-heater, the visitor's attention is directed to a meter-board upon which is mounted a watthour meter showing the actual energy consumption and corresponding operating cost; a water meter showing the boiler input, and a graphic thermometer connected to the top of the tank showing how perfect is the temperature control of the water leaving the tank, whether one or thirty gallons are drained from the boiler. Direct reading thermometers are also inserted at the top, bottom and middle of the tank, indicating the temperature of the water at different levels in the boiler, and clearly demonstrating the perfect circulation effected by the specially designed immersion heater.

It is needless to remark on the interest that has been displayed by visitors in this electric water-heater, which has a thermal control capable of adjustment to operate at any temperature between 75 and 175 degrees Fahrenheit. These heaters, equipped with a thermostat and adaptable for insertion in any standard household boiler, are being manufactured by the Electric Sales-Service Company of San Francisco.

The thermostat, though extremely simple, is a scientific instrument and has a record of three years' continuous operation without an adjustment, in maintaining temperatures to an accuracy of half a degree.

The most novel feature of the installation, aside from its life-long guarantee, however, is the design of the heating element, which is built up in six or more sections of 250 watts each. Each section is separately controlled by the thermostat and the regulation is such that the individual units are consecutively cut on and cut off the service line one at a time, at intervals of about one minute, as the temperature of the water passes below or above that point at which the thermostat happens to be set.

By reducing the instantaneous increase in demand to a minimum of 250 watts, regardless as to whether the total capacity is 1000, 2000 or 3000 watts, the multiple control prevents any disturbance to the residence power circuits, such as blinking the lights, which effect may often be noted in the case of even a 500-watt electric iron.

This type of heater is as advantageous to the central station in terms of the character of the load it produces as it is to the consumer in terms of economy of operation, for it is inherently an off-peak load; not off-peak in terms of day and night load, but off-peak with respect to the cooking peak, which, in the light of the rapid increase in the cooking load, is the new peak which the domestic feeder load curves are now developing.

Hot water is used in greatest quantities just after meal-time, and the multiple control is so designed that it lags from 20 to 40 minutes after the water is drawn, which throws the water-heating load into the valley just following each meal-time cooking peak.

The diversity factor which will be obtained on great numbers of these heaters, each intermittently operating and having individual diversities of six, would seem to indicate that this heater opens up a new field of central station endeavor even larger and more profitable than electric cooking.

The electric heating and cooking department in San Francisco is in charge of R. A. Sharon who, with a corps of assistants, now devotes his time exclusively to this branch of the company's business.

PARALLEL OPERATION OF ALTERNATORS.

BY L. J. CORBETT.

(This paper discusses the effect of differences in speed, field excitation, wave form, and voltage and speed variations with load variations of alternators connected in parallel, special attention being given to difficulties in the parallel operation of water-wheel and gas or steam engine driven units. The author is professor of electrical engineering at the University of Idaho, at Moscow, Idaho.—The Editor.)

The first recorded instance of parallel operation was in 1869 when Wilde demonstrated that two machines producing an alternating current could be run upon the same load. This was lost sight of for sixteen years while investigators were ignoring the possibilities of alternating current and developing the direct current system. In 1884 Hopkinson showed by mathematical analysis that the parallel operation of alternators was practicable, and later demonstrated the fact by experiment. But even then the significance was not appreciated by the commercial world for the day of the transformer was not yet. So we find that commercial use of this discovery was not made until well along in the 80's when alternating current commenced to be a serious competitor of the direct current system, and more especially after 1892 when polyphase transmission was fully demonstrated.

When these principles were first utilized, it was on a small scale within the small plants of the day. As was already practiced with direct current machinery, it was found possible with the alternating current units to add unit after unit as the load upon the plant required and thus keep operation at a fair degree of efficiency. The same principles have been expanded since the days of polyphase current and we now have not only alternating current machines running in parallel in the same station, but stations operating in parallel, feeding the same distribution district in a large city, and stations operating in parallel feeding into an extended system of miles upon miles of high tension transmission and tie lines furnishing power perhaps to several municipalities.

Some features of parallel operation are within the control of the manufacturer alone, and some are within the control of the operator. Still others are to be controlled by the electrical engineer, who designs the plant, and even by the construction foreman.

Properly speaking, any alternator may be run in parallel with any other alternator. Any single phase machine may be run in parallel with any other single phase alternator, or with one phase of any polyphase alternator. One phase of any polyphase machine may be run in parallel with one phase of any other polyphase alternator. Usually, in present practice, we have all phases of a polyphase alternator running in parallel with all phases of another alternator or of an operating polyphase system of the same number of phases. For first consideration we may limit our study to the operation of a single phase of one alternator with a single phase of another, with no more than a limited amount of station wiring, switches, etc., connecting the machines.

From this standpoint the ideal conditions for parallel operation are:

(a) The speeds of the machines must be such that the frequencies are the same.

(b) The field excitation of both machines must be such as to give the same effective voltage at the point of connection.

(c) The form of the waves of e.m.f. of the two machines must be identical.

(d) The "compounding curves" of the two machines—the variation of voltage with percentage variation of load, must be the same.

(e) The curves of regulation of the prime movers driving the machines—the variation of speed with percentage variation of load, must be identical.

If these several conditions obtain, after the machines are synchronized and the first adjustments made, there will be little for the station operator to do. If these ideal conditions are maintained, we can readily see that there would be no cross-currents causing losses in the connections.

What we know as satisfactory parallel operation falls far short of this in every one of the requirements. We depend upon the cross currents to hold our machines together, and allow ourselves wide latitude in many of these particulars. It is the purpose of this article to consider in a general way variations from the ideal conditions and their effects.

Alternator Speed.

Taking up the first division we find the speeds of the alternators the field in which the most trouble was experienced in the early days of parallel operation, and in which it is still to be found in certain classes of plants. Water wheel and steam turbine units are particularly free from trouble in this respect as they have imparted to them a uniform rotary motion, and it is possible to regulate their speed to an extreme nicety, so that cycle after cycle of voltage

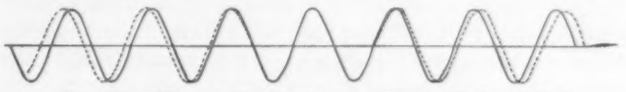

Fig. 1. Effect of Paralleling an Engine Driven Unit with a Uniformly Rotating Unit.

from two units will rise and fall in perfect step. But once introduce a steam or gas engine into the system—any reciprocating engine unit—and this condition is affected to a greater or less extent, because of the variation of speed at various parts of the stroke. The average time of a revolution of the alternator may be such as would give the proper average frequency, but the actual speed will swing from faster to slower than the average. If then an engine-driven unit is paralleled with a uniformly rotating unit, it will forge ahead for a few waves, be in synchronism for a wave or two, then drop back behind the other for a few waves, and then speed up again as before. While it is ahead of the other machine it will furnish current not only to the common load but also to the first machine to the extent allowed by the differences in voltage from instant to instant and the impedance of the completed circuit between the machines. While it is behind the other, the smooth running machine will send current through the circuit connecting the two. These cross currents are not wattless, but transfer energy back and forth between the machines in order to keep them in step, or within the limits of variation allowable before they will fall out of step. Should they

fall out of step, the protective devices will cut one or the other machine out as soon as the difference between the instantaneous voltage is sufficient to force through the circuit the current for which they may have been set.

Alternators coupled to steam or gas engines are subjected to impulses at certain points during each revolution. Such a unit when paralleled with a turbine or water wheel unit gives rise to cross currents of the nature just described. When two units of this character are run in parallel with each other, the conditions are liable to be aggravated. Even if the two units are of the same characteristics the machines may be thrown together in such a way that the impulses come at different parts of their respective revolutions. When one is going fast on admission, the other may be going slow on compression. The cross currents between the machines will be eliminated if they are so connected that the impulses coincide, but the frequency of the whole system then rises and falls, and this condition causes pulsation between the set of generators and any synchronous motors or converters on the circuit, reducing their maximum output. This is noticeable even in cases of small variations in angular velocity of engine speed.

Fig. 2. Steam Engine Card.

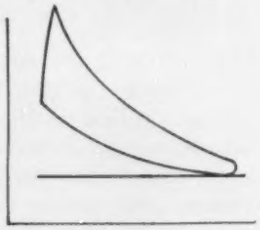

Fig. 3. Gas Engine Card.

Difficulty is encountered when units of the same kind, but of different speeds and different numbers of poles for the same frequency, are run in parallel; for impulses are constantly forcing one machine or the other ahead, and causing cross currents between them. At certain periods these impulses may coincide and at others they may be opposed and make it difficult for the machines to keep in step. In many plants containing such units, the condition of parallel operation is unstable; possibly the machines will run smoothly together under steady load or under steadily changing load, but if sudden fluctuations occur, the breakers are opened on some occasions but not on others, although the fluctuation may have been of the same amount and character.

Under the same category might come the use of units driven by different types of steam engines, such as a single cylinder or tandem compound engine unit paralleled with a cross-compound or triple expansion unit. A peculiar instance is reported by F. D. Nims as having occurred in Mexico City. In one station there was a 3-phase 60 cycle alternator driven by a triple expansion upright engine without a flywheel. Connected to the main shaft by a crank was a heavy displacement pump for circulating the condensing water. To compensate for the weight of the piston of the displacement pump, the cranks were spaced, not all 120 degrees apart, but about 115, 120 and 125 degrees. This unit operated in a satisfactory manner alone, but in an unstable and unsatisfactory manner when paralleled with the rest of the system. A heavy and regular pulsation was set up throughout the circuit. This of course is an extreme case, but it illustrates conditions to be guarded against, and it shows what occurs to a lesser extent when units whose impulses differ in time are operated in parallel. The gas engine must come in for its share of consideration, as the nature of its cycle differs from that of the steam engine. Inspection of the indicator cards of the two types of prime movers will show what difference may be expected in their angular velocities at different parts of stroke at any stage of load.

It must not be assumed that the writer is blaming all hunting troubles to angular variation alone. If governors were perfect, the average speed of a revolution constant in every case, we would still have cross currents between machines due to the conditions just described, but they would not be responsible for hunting. This is a complex phenomenon depending upon a number of factors. In engine driven units it is often said to be the fault of the governors but it is also to be found when synchronous motors or rotary converters are connected on the line. The angular variation does, however, introduce into the system an unstable condition every few cycles, independent of load changes, and if units are so related as to fly wheel weight and governor action that they are liable to hunt, that condition will be ever present.

Field Excitation.

A matter which has come in for a great deal of study and discussion is the effect of variation of field excitation. The change from direct current to alternating current had a certain amount of inertia to overcome in the methods of the station operating force. It was a simple matter to weaken the field of one direct current generator, feeding into a system until the ammeter reading fell to zero and then open the switch without producing an arc. But the same method applied to an alterantor had no such result. The ammeter showed no diminution of current, possibly even an increase as the field was reduced, and if the reduction was persisted in, increasing pulsations would occur until finally the breakers, or the expulsion fuses used in those days, would open the circuit.

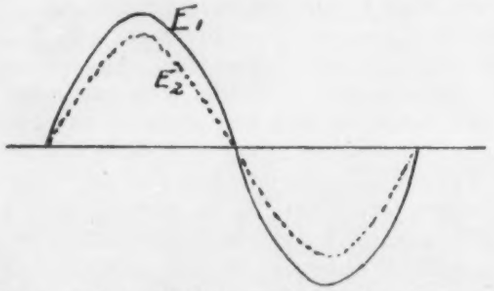

Fig. 4. Effect of Difference in Field Excitation of Rigidly Connected Units.

If the two alternators are excited so that the waves of e.m.f. coincide in value at all points there is no exchange current between them. If, however, one machine has a higher excitation than the other we do not have such a condition as represented in Fig. 4, unless they are rigidly connected together. What we do find is the condition shown in Fig. 5, an actual

displacement in phase of the e.m.f.'s supplied by the machines of the external circuit. To complete the triangle, there must exist an e.m.f. between the two machines, which causes a current to flow between them, its value depending upon the impedance of the machines and the connecting circuit. Or referring to the curves of voltage as platted, the curve E_3 of e.m.f. between machines or tending to send current through the series circuit, is such a curve that if added to E_2, the e.m.f. of the under excited machine, the result will be E_1.

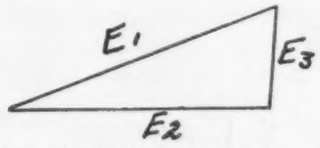

Fig. 5. Phase Displacement Caused by Difference in Field Excitation.

A paper by Welsh, before the A. I. E. E. at Portland in 1912, presents a treatment wherein load is said to be shifted in two ways, by adjustment of the governor of the prime mover, and by field adjustment. As was brought out, however, in the paper and particularly in the discussion, field adjustment served the

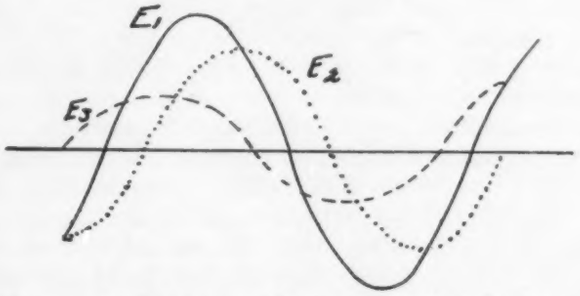

Fig. 6. Usual Effect of Difference in Field Excitation..

purpose only when accompanied by a change in governor setting; and when stations were connected through lines chiefly of resistance, raising the bus bar voltage of one plant and lowering it in another caused a transfer of load.

Within the limits of one station, however, with the ordinary low resistance station wiring between machines, no appreciable change in actual load can be made by varying the field excitation. The power factor of the load the machine is carrying will be altered, but with any given setting of the governor the power will be the same. Increasing the field excitation will cause the generator current to lag, while lowering the excitation will cause the current to lead the bus-bar voltage.

Any difference in the excitation causing the effective values of e.m.f. to differ, causes cross-currents between the machines with the attendant magnetizing and demagnetizing effects of the leading and lagging armature currents.

Wave Form.

When two alternators differ in wave form, they may have the same effective value of e.m.f. and run in parallel, but there will be high frequency exchange currents between the machines. If two curves such as are shown in Fig. 7 represent the waves of e.m.f. of two alternators E_1 and E_2, the curve E_3 will indicate the difference between them from instant to instant, and due to this difference, an exchange current will flow between the machines. This current will be more or less distorted depending upon the har-

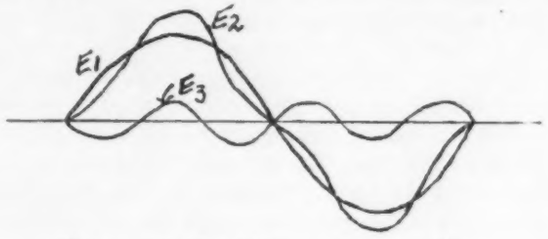

Fig. 7. Effect of Difference in Wave Form.

monics present and upon the characteristics of the series circuit. It will be superposed upon the regular synchronizing current upon which we may be depending to keep the machines in step, and at times of load change will tend to additional instability. Another effect of the higher harmonic cross-currents is to set up rotary fields which are superposed upon the alternator fields. The rotation of the field of the third harmonic is in the opposite direction to that of the alternator field, and if this component is large it may seriously affect the parallel working. The amplitudes of the fifth and seventh harmonics are usually so small that their effects are not serious, but they add to the resistance, hysteresis and eddy current losses.

Compounding Curves of the Generator.

In the ordinary course of operation of a power plant, typified by a plant supplying a lighting load, the load changes are gradual. If we have machines of different characteristics so that the voltage of one drops to a greater extent with a given percentage addition of load than the other, we will not have a proper division of load between the two, and though they may be adjusted for proper division of load of a certain value, for any other value, one will be over-excited and the other will be under-excited, leading to conditions discussed under that heading. Closely allied to this is the matter of the curves of regulation of the prime movers driving the generators, for upon the governors depends primarily the division of load. If the governors do allow equal division of load at all percentages of load, but if the excitation does not vary in the proper proportion in both machines, they may carry their proper share of load but with excessive cross currents which introduce losses, excessive armature reaction, heating and instability.

The actual division of load as has been stated, depends upon the governors and their regulation of the prime movers. If we had what is called an "Ideal" governor we would have a perfectly flat speed curve. With such perfectly flat speed curves on both of two prime movers, we would have no tendency for load division whatever between them, and upon a change of load occurring on the mains, the load division would be due to very complex interrelated causes. It would be influenced by field adjustment to a greater extent in this case than in any other, but also by the characteristics of the con-

necting circuit and by the power factor of the load. The load division would be decidedly erratic and eminently unsatisfactory. It would depend upon Professor Franklin's "Physics of Chance," whether the load would swoop to one machine or the other, for the governor's work would be accomplished when normal speed was restored, whether there was no load on the alternator connected to its prime mover or an overload. Fortunately for parallel operation, governors can be set to allow a variation of speed from no load to full load. If the governors on both units, or on all the units in a power house, are set to allow the same variation in speed for the same variation of load, and if they are of the same type of governor, thus having similar curves of regulation, then the governors will automatically cause the sharing of the load properly among the respective units, for if load tends to come upon one unit the speed will slow down and the faster turning units will then relieve it of load, allowing it to increase in speed and so on until the speed of all units is the same and the load is properly divided among them. A satisfactory amount of drop for prime movers from no load to full load is 2 per cent.

So far as the generating units are concerned, these points should be kept constantly in mind, and proper precautions taken to eliminate, as far as possible, unfavorable conditions. We have come to depend upon the synchronizing current between machines to hold them in step, and it should be our aim to so design and operate a station that this current is kept at a reasonably low value. In a well-designed and well-operated station the synchronizing current is ordinarily at a low, practically negligible, value, except when changes of load occur, at which time they may increase momentarily until the proper adjustment of load is obtained, when they again subside. The selection of prime movers should be made with reference to the uniformity of rotation as well as other economic conditions, and in general, types differing too greatly in angular variation should not be chosen, or if chosen proper fly wheel weights should be used to keep the angular variation within suitable limits. Here again we have to be careful in our selection of fly wheel weights. If very heavy fly wheels are chosen there will be rather long natural periods of vibration, and any surging which may tend to develop will be eliminated by the governor. On the other hand, if very light wheels are used, the synchronizing currents are able to act much more quickly than the governor, so the task of maintaining the speed devolves upon them. Intermediate between these extremes, surging is apt to occur and to be assisted by the governor unless proper adjustment of its dash pot is made. Without such adjustment the task of synchronizing currents, of keeping the machine in step, becomes more and more difficult as the weight is increased within the limits of this intermediate zone. Common practice is to allow an angular variation of $\pm$ 2.5 electrical degrees. For this variation greater fly wheel weight will be necessary in a gas engine or a single cylinder steam engine than in a triple expansion engine.

In choosing generators it is common practice to have all the units of a power house made according to the same specifications. It frequently happens, however, that units are added to a plant in later years, and in that case it is well to guard against selecting units of a different wave form. It may be inadvisable to get machines of the same pattern as were first installed, but they should at least conform in general features, so that the wave form of the first machine will be approximated, if we would avoid needless waste of energy in cross-currents. For instance, we may expect cross-currents if the new machines have two slots per pole per phase and the old ones three.

If an entire station be added to a system and connected by a transmission line of appreciable resistance and impedance, the cross-currents will usually be insignificant.

In the field adjustment lies perhaps the greatest possibility of eliminating needless cross-currents within the control of the operator. If the compounding curves of the alternators are alike they will maintain their proportion of load (provided the governors are properly set) though the voltage will drop unless some provision is made to keep it up. The voltage of the bus-bars can be raised by increasing the fields of all the units. Cross-currents can be guarded against by using power factor meters on each machine and adjusting the fields so that each of these agree with that on the mains, or by occasionally testing the field adjustment for minimum armature currents as indicated by ammeters on each board. These adjustments are interdependent among the machines, and may have to be repeated a time or two before the final result is obtained.

CHANGES AT GATUN HYDROELECTRIC STATION.

Extensive changes have been authorized for increasing the capacity of the hydroelectric plant at Gatun, Panama Canal. New turbine wheels have been ordered for the three turbo-generator sets, each of 4400 h.p., instead of 3100 h.p. as at present. No change will be made in the generators, as the very liberal design of these units makes it possible to operate them with an output of 3650 k.v.a., at 80 per cent power factor and 55 degrees centigrade temperature rise.

In order to take care of the increased output of these generators, four new 400,000 circular mil cables have been ordered for installation between the hydroelectric station and the Gatun substation. The present cables between these two points are ten in number and are of No. 0000 size, which corresponds to an area of 212,000 circular mils. The necessary switches, instruments, etc., for these cables have been ordered both for the hydroelectric and the Gatun substation.

In addition, two 4000 k.v.a. power transformers have been ordered for the Gatun substation. These are the largest transformers that can be installed in the existing compartments. There is now one vacant compartment for one of these transformers, and the other compartment will be procured by moving one of the present 2667 k.v.a. to the Cristobal substation, where it will be needed to take care of the increased load at that point, due to the operation of the new coaling plant, and the new terminal piers, and to the projected submarine base at Cristobal.

CRITICISM OF FERRIS BILL.

BY C. C. CHAPMAN.

(This letter was written by the author to an Eastern banker who made inquiry concerning the Ferris water power bill. It formed the basis of a talk before the Luncheon Club of the Section of A. I. E. E. and N. E. L. A., Portland, Oregon, March 30, 1916. Mr. Chapman is editor of the Oregon Voter.—The Editor.)

Referring to your inquiry concerning the objectionable features of H. R. 408 (the Ferris Water Power Bill), will state that as reported back to the Senate by the Senate Lands Public Committee, many of said objectionable features have been eliminated.

There is danger, however, that same will be amended back into the bill either from the floor of the Senate or in conference.

The House leaders and many of the Senators are strongly in favor of radical, repressive legislation, and when the bill goes to conference there is a strong probability that extreme views will prevail and that many of the objectionable features will be restored. I gravely apprehend the bill will be passed in form that virtually prohibits extensive water power projects where the use of any portion of public lands for power sites or rights of way is involved. The only hope for fair legislation is to continue to impress the senators and representatives with the necessity of enacting conditions that afford reasonable security to an investor and a prospect of ultimate reasonable profit.

The House bill "authorized and empowered" the Secretary of the Interior to lease public lands for water power development. The Senate amendment "authorizes and directs." The theory of the Senate amendment is that after an applicant for a lease has gone to great expense locating a site, finding a market for power, preparing plans, and arranging his finances, and in his application conforms with all of the conditions laid down by law, the Secretary should be required to consider his application in the order in which it is received for the particular right; and if the applicant is entitled to the lease it should be mandatory upon the Secretary to allow said application. Lodging discretion with the Secretary by "empowering," not "directing" him to lease would enable him to play favorites. It is doubtful whether capital will undertake the heavy expense of engineering and financing when it is feared that the Secretary may reject the application in favor of some other applicant who is more highly regarded by the Secretary. Water power developers are entitled to know in advance what the conditions are with which they must conform, and to know that when they have conformed with said conditions the government will grant the lease sought.

The House bill empowers the Secretary to make leases "for a period of not longer than fifty years." The Senate amendment directs that leases be made "for a period of fifty years unless the applicant and the Secretary agree on a shorter period as the applicant for lease may elect." Under the terms of the House bill the Secretary may arbitrarily reject an application for a fifty year period or insist that it be reduced to a fewer number of years. Under the Senate bill the applicant would have the right to apply for a fifty year lease, or for a lease for a less period as the applicant might elect. Again, this gives the applicant the definite right instead of placing him entirely at the mercy of the Secretary.

Under the House bill the Secretary is empowered to make a lease "under general regulations to be fixed by him and under such terms and conditions as he may prescribe." In the Senate amendment the Secretary is directed to lease simply "under general regulations to be fixed by him," and he is not empowered to prescribe terms and conditions other than those imposed by the Act itself and published regulations. It is readily apparent to any business man who has had dealings with the government that in applying for a lease he should be permitted to know in advance the terms and the law and regulations so he can plan accordingly, and should not be placed at the mercy of department or bureau officials who later might prescribe terms and conditions of a character of which, had he known same in advance, would have convinced him of the uselessness of undertaking the proposed costly development.

The House bill gives an advantage to states, counties or municipalities for municipally-owned electric plants, and specified that the Secretary may in his discretion "give preference to such application."

The Senate amendment plays no favorites. It neither denies to municipalities the right to apply for leases, nor does it discourage the private investor from undertaking expensive development by notifying him in advance that after he has gone to heavy expense the law permits the Secretary to reject his application in favor of an application made by a state, county or municipality, possibly for the sole purpose of defeating the original application made by private capital. Both bills also provide that no rental charge shall be made for lease to municipally-owned plants, thus again putting a premium upon hydroelectric development to be undertaken at the expense of taxpayers in contrast with development to be undertaken by private capital, saving the taxpayers of municipalities all the cost and risk of going into a business which might be engaged in by private capital if conditions were equal.

The House bill requires of the Secretary of Agriculture to certify that the development of power will not be inconsistent with the purpose for which a forest reserve was created. This requirement has been eliminated in the Senate committee amendment, thus avoiding the danger that after an applicant shall have gone to such heavy expense in good faith and bound himself to conform with the law and the regulations, he shall not further have to negotiate with an entirely different department of the government and be at the mercy of the officers of an entirely different department which can impose new conditions which, if understood in advance, would have deterred the applicant from undertaking his project at all.

The House bill provides "that the lesse shall at no time contract for the delivery to one consumer of electrical energy in excess of fifty per centum of the total output, except upon the written consent of the Secretary of the Interior." This lodges power with the Secretary to reject a lease for a project which might be built for the sole purpose of supplying electric power to a railroad, to a large manufacturing establishment (for instance for the manufacture of fixed nitrogen), or for any other one industrial use. If a lessee should

propose to develop 50 h.p. to be sold to one railroad he might be required to develop another 50 to be sold to communities which already were over-supplied with electric energy for general use, or he might be limited to the sale of only 25 of his 50 h.p. development to the railroad which could use the whole fifty and would be forced to find a market for the other twenty-five under conditions which would make it practically impossible for him to find such market in the particular locality in which his power is available. Capital will hesitate to undertake such needed development to supply power to railroads, or single large industrial users, when facing the contingency of having to develop twice as much power as is needed for the particular use and having to find a market for the excess.

The House bill lodges with the Secretary of the Interior the power to regulate Interstate Commerce in electric energy from such plants as are operated under the government leases. The Senate committee reposes this power in the Interstate Commerce Commission.

The House bill lodges with the Secretary of the Interior the power to regulate the issuance of stocks and bonds by the lessee. The Senate amendments eliminated this.

It should be remembered that this proposed regulation, both as to service and issuance of securities, is restricted solely to lessees of government land under the proposed Act; it does not apply to interstate use of power on lands no portion of which are leased from the government, or to issuance of securities by corporations which are in no wise dependent upon government leases. Thus the Act is discriminatory in providing federal regulation for one class of power companies while exempting all other classes of power companies from regulation, either as to price, service or issuance of securities. This is a rank discrimination against the Western public land states.

The House bill requires the written consent of the Secretary of the Interior for any sale or delivery of power (excepting thirty-day emergency sale) by the lessee to any distributing company, and also requires the written consent of the Secretary for the assignment or transfer of the property depending on the lease, or for physical combination of plants. The Senate amendment permits the lessee to sell power wherever he can, subject to law and the local public service regulations, and also permits the sale or assignment of the lease itself. It will readily be seen that any secretary controlling the business transactions of a lessee would be in a position to dictate ruinous terms whenever application is made for his consent to a purely business transaction.

Both bills provide that the United States shall have the right to take over all the properties that are dependent in whole or in part for their usefulness on the continuance of the lease. This provision confronts the investor with the contingency that all the properties in which he has invested,—perhaps great distributing systems covering chains of communities for which most of the power obtained is from privately owned lands—may be taken over by the government at the expiration of the lease on one power site, or even on the right of way over a distributing line which may supply only a small portion of the energy which goes into the general distribution of all the properties with which he is connected. The government by virtue of leasing only one small power site, or a right of way for a poleline has the edge on controlling an entire distributing system which is dependent only in part on power sites or right of way leased from the government. This would be in spite of the fact that the very water used on the government land actually belongs to the state. Power developments are very costly and hazardous; and to limit the hope of return to a fifty year period at the end of which all the properties, even indirectly connected, could be taken over by the government, is to deter and discourage investment.

The House bill provides that the government, in taking over the property, shall pay, first, only the actual costs of rights of way, water rights, lands and interests that are owned by all the properties connected with a government-owned site or right of way, and, second, the reasonable value of all other property limited by the drastic provision "that such reasonable value shall not include or be affected by the value of the franchise or good-will or profits to be earned on pending contracts, or any other intangible element." This severe provision forces the investor to realize that all the value of good-will of an established business, built up by years of pioneering and development expenditures covering all of his properties, shall entirely cease at the termination of a lease covering only a small part of his system. The Senate amendment substitutes for this drastic provision the very reasonable and satisfactory requirement "that such fair value shall not include or be affected by the value of any public lands, rights of way, franchises, or other property leased or granted under this Act by the United States"; but adds to that proviso the onerous condition "or by the good-will or prospective revenues." No one objects to excluding all the value of the property of the United States from any reimbursement to be made to private capital. There is no longer any serious attempt to appropriate to private profit United States property in power sites or rights of way for transmission lines; but investors do object to losing all the good-will of an established business at the end of the lease period on a lease which covers only a small part of the power generated and sold in a large business.

The Senate bill provides that in the event the United States does not exercise its right to take over the properties and makes no lease of all of said properties to a new lessee, the old lessee shall be permitted to continue in ownership and control of his properties There is no such permission in the House bill.

The Senate amendment also gives the original lessee a preference right on renewal, while the House bill gives the original lessee no such preference right.

The House bill specified that when "in the judgment of the Secretary of the Interior" the public necessity requires or justifies the lessee in contracting for the sale of power beyond the life of the lease that such contracts may be made for a period of twenty years beyond the termination of the lease. The Senate bill lengthens this period to twenty-five years, and lodges no such discretion in the judgment of the Sec-

retary of the Interior, merely requiring that such contracts may be entered into upon the approval of the Public Service Commission of the state and of the Secretary of the Interior, subject only to laws and public regulations, instead of permitting the Secretary to determine the matter arbitrarily.

Both bills permit the Secretary to fix the charges for land leased on the basis of the power developed and sold. This arbitrary rate-fixing power should not be lodged with an administrative officer. He can specify one charge to one lessee and another charge to another lessee. The charge should be fixed by law and should be alike to all who develop and use the same number of horsepower. Then the developer will know in advance what charge he must face; and if he does not see his way clear to make a profit on the basis of the other charge fixed by law, he can drop the subject. If he is confronted by the contingency that an arbitrary official can fix a charge based on that official's estimate of the possible profit to be made from the project, and based on a political policy of squeezing nearly all the profit out of a particular project, it is doubtful whether many investors will care to face such a possibility.

Both bills require that leases made to municipal plants shall be without charge for power. This is a discrimination against private capital, and puts a premium on municipalities undertaking risky and costly power development at taxpayers' expense; when, if conditions were equal, private capital might be induced to make the development without burdening the taxpayers.

The House bill prescribes that the Secretary of the Interior shall regulate rates and service in any state which has no public utility commission. This provision is aimed squarely at the state of Utah, which alone of all far Western states has declined to establish a public utility commission on the theory that every encouragement should be held out by Utah to capital to develop its natural resources without fear of having the profit regulated out of the business. This is a local policy and should not be penalized by the Government.

Both bills require that the lessee may be required by the Secretary of the Interior to submit statements and reports covering every detail of every ramification of business in all the properties connected with the power plant or transmission line which happens to be located on government land, irrespective of whether any considerable proportion of the power actually used comes from or over government land. This simply makes one more series of reports which must be filed by a corporation, and another authority with whose rules and regulations the corporation must conform in its accounting. Already the burden of accounting and reporting to different public authorities is almost ruinously heavy; and it seems an economic crime to require that still further detailed reports shall be made to still other official authorities under new conditions to be prescribed by them.

A rank piece of hypocrisy is in both bills—"that nothing in this Act shall be construed as affecting or intending to affect or in any way interfere with the laws of any state relating to the control, appropriation, use or distribution of water." By virtue of owning the power site and right of way the government assumes and enforces control over every feature of the use of the state's water. And this section is inserted merely as a sop to the people who believe that the state should have something to say about the use of the water which it owns. The section is meaningless and viciously deceptive.

The House bill requires that each lease shall be conditioned upon the acceptance by the lessee of all the terms specified in the lease, which sounds all right until it is remembered that the Secretary of the Interior (and in some cases the Secretary of Agriculture) has authority to insert arbitrary conditions in said lease, which conditions, if known in advance, would have prevented the investor from going to the enormous expense of engineering and financing the project.

To summarize, the bill as it passed the House is so drastic and restrictive in its actual terms, and imposes such a degree of arbitrary authority upon the Secretary of the Interior (and in some cases on the Secretary of Agriculture) that the prospective developer will hesitate to take a chance on reaping an ultimate profit from his investment unless he stands so well with department and bureau officials that, by virtue of his acquaintance and the personal regard in which his political opinions are held, he is enabled to secure favorable terms, regulations and special conditions from the secretaries.

To summarize; as amended by the Senate committee, several of the most drastic provisions are removed and other conditions are made definite instead of being left to the arbitrary whim of an administration officer. However, the Senate amendments do not go far enough. The charge to be made for water should be fixed by law and some other burdens should be removed.

It should be clearly kept in mind at all times that no attempt is being made to appropriate to private profit any of the value of the government lands or of leases obtained from the government; that no attempt is made to obtain provisions that would permit capitalizing these intangible values; and that no one seeks to have the government give its power sites in perpetuity to private individuals who can reap a large profit from the value of said lands. Advocates of the Ferris bill raise the hue and cry that opposition to it is dictated by people who desire to appropriate government lands and capitalize their value, thus reaping enormous profits from the value of the sites and rights of way. These allegations are absolutely false and should not be permitted to mislead public sentiment.

Both bills prohibit liens on any related properties without consent of the Secretary. When all a company's properties are covered by a mortgage upon which bonds are issued from time to time, further issuance of said bonds would be impossible after the company become a lessee of any government lands unless the Secretary approved all the terms of the original mortgage; and the mortgage could not be modified to meet his exactions without the consent of holders of earlier bonds.

THE MEDLOW DAM.

BY PERCY ALLAN.

(This interesting account of the features of a thin profile dam, as compared with the Bear Valley dam in California, is taken from the Commonwealth Engineer of Melbourne, Australia.—The Editor.)

The Medlow dam, on account of its slender profile, is one of the most remarkable in the world. It stands as a sheet of concrete in a sandstone gorge on Adams Creek, in the Blue Mountains of New South Wales. The wall, with a vertical upstream face, is built on a curve of 60 ft. radius, and is 65 ft. high from the foundation to the top of the parapet. The wall has a base width of only 8.96 ft., tapering on

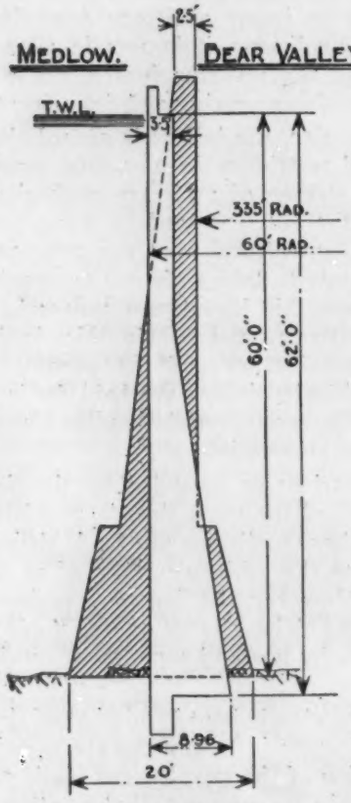

Fig. 1. Comparison of Profile.

the downstream face to 3 ft. 6 in. at a height of 29 ft., thence 3 ft. 6 in. to top water level, finishing with a parapet wall 1 ft. thick for the remaining 3 ft. of height.

Although the old Bear Valley dam, built in California in 1884, and superseded in 1911 by a multiple arch dam, has in the past been referred to as having the thinnest profile in the world, yet a dam built on Crowley Creek, in America, in the same year as Medlow Dam has a thinner profile, whilst Fig. 1 shows the profile of the Medlow dam to also be thinner. The Medlow wall, however, is—due to the narrow gorge—built on a very much smaller radius, viz., 60 ft. as against 335 ft., the maximum pressure on the concrete being only 12 tons per sq. ft., as against 53 tons per square ft. on the granite voussoirs in the old Bear Valley dam.

In determining the profile of the Medlow dam, the wall was treated as a section of a rigid cylinder, subject to external water pressure, any assistance due to the weight of the wall being disregarded.

The formula used was: $-\mathbf{T}. = \frac{\mathbf{RP}}{\mathbf{S}}$

where **T** denoted the thickness of wall at any level in feet,

where **R** denoted the radius in feet,

where **P** denoted the water pressure in tons per sq. ft., and

where **S** denoted the stress in tons per sq. ft.

The limiting pressure adopted for the concrete was 12 tons per sq. ft., whilst the highest water surface was taken as within 1 ft. of the top of the parapet wall, or 2 ft. above the overflow of spillway.

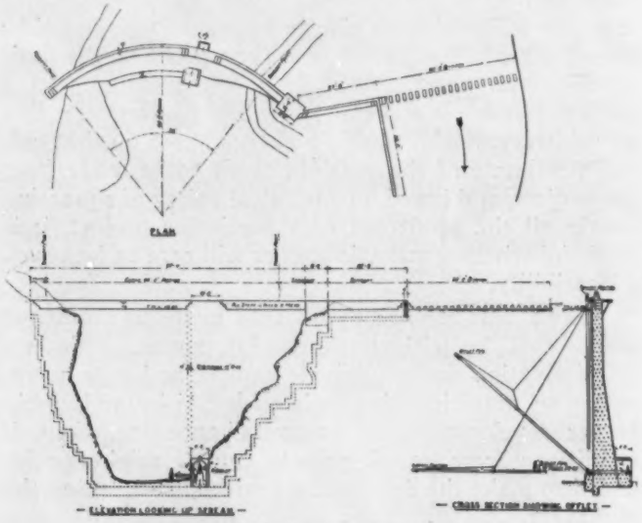

Fig. 2. Mellow Dam Sections.

$$\mathbf{P} = \frac{62.5 \times 62}{2240} = 1.73 \text{ tons.}$$

$$\mathbf{T} = \frac{60 \text{ ft.} \times 1.73 \text{ tons}}{12} = 8.65 \text{ feet.}$$

The dam is built of concrete without any reinforcement or "plums." The concrete was composed of 13 cu. ft. of ironstone 2 in. gauge and 8 2/3 cu. ft. of ¾ in. screenings, to 13 cu. ft. of sand, to 375 lb. of cement.

With a view to determining the crushing strength of the concrete as under actual conditions in the work, samples were taken from time to time off the banker board, just as the concrete was being placed in the work, and were then made into 6 in. cube blocks. The seven blocks tested showed at two months a crushing strength of 93 tons per sq. ft., and at three months from 93 tons up to 116 tons per sq. ft.—the limit of the machine. One block, however, at 35 days also beat the machine at 116 tons per sq. ft.

Good close sandstone was met with in the foundation trenches, but on either side considerably more excavation had to be taken out than was anticipated in the office plans, as fissures and large bands of iron stone running in all directions had to be contended with.

Along the front line of trench, at intervals of 6 ft., holes, reaching to the bottom of the foundation, were left in the concrete, whilst chases were cut in the different benches in each cliff. After the concrete had thoroughly set, iron pipes were temporarily cemented

in the holes and chases; cement grout under pressure was then forced down the pipes with a view to filling any spaces between the rock face and concrete.

The whole of the concrete was mixed by hand, on a platform located at the top of the southern cliff, and delivered thence into a hopper provided with a long timber chute reaching to the bottom of the foundation, or such position on the wall as required.

Fig. 2 shows various sections, etc., of the dam. Fig. 3 shows the finished dam.

To provide a supply of water for concrete, two small tanks with earthen bag wall dams were excavated at a level to command the mixing platform, the water being raised from the creek bed by means of a No. 7 Danks' hydraulic ram. To obtain the necessary head of 12 ft. for working the ram a timber dam

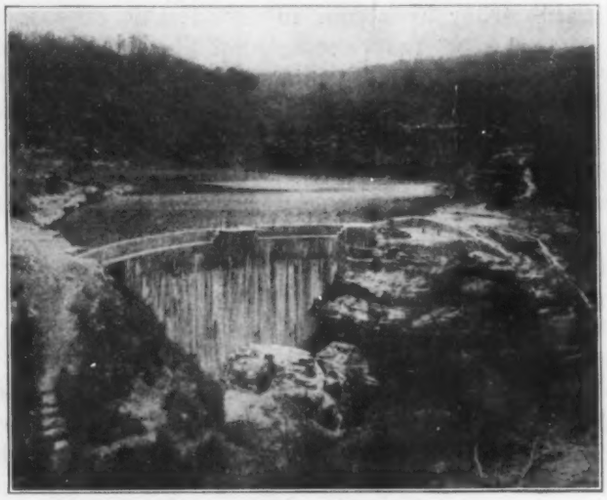

Fig. 3. The Finished Dam.

faced with a clay bank was built some little distance upstream of the site; thence along the bed of the creek was laid the drive pipe of artesian bore casing, some 489 ft. long by 4 in. outside diameter. The delivery pipe was 1½ in. inside diameter and 335 ft. long. The ram discharged into the upper tank against a head of 130 ft., exclusive of friction. Under these conditions, the ram discharged 54 gallons per hour. Both tanks were filled before starting the concreting, and with a continuous supply of 54 gallons per hour, no shortage of water was experienced in working the 48 hours a week. A batch of concrete was usually found to require 35 gallons of water.

The vertical timbers supporting the profile boarding were of 6 in. by 4 in. hardwood, blocked off the concrete and connected thereto each with two 7/8 in. bolts, with nuts at each end, built 10 in. into the concrete. The bolts were oiled and no difficulty was experienced in unscrewing them from the nuts which were left in the concrete, the hole being then washed out and plugged with cement mortar.

The lagging was of dressed tongue and groove Oregon pine, 1 in. thick, nailed to 6 in. by 2½ in. dressed pine horizontal ribs cut to radius, the segments being 4 ft. 6 in. deep and in 6 ft. 6 in. lengths. The face of the lagging was coated with soft soap immediately before the concrete was placed in position, the concrete being allowed to set for 48 hours before the profile boarding was removed; the concrete face was then given a coat of cement wash.

A natural depression on one side of the gorge was fashioned into a spillway, discharging some little distance downstream of the dam, whilst the parapet wall of the dam itself, 3 ft. above the over-flow level of spillway, ensures the whole of the flood waters being passed into the creek without over-topping the dam—a matter of first consideration, with a thin wall without water cushion at base.

The catchment area is 1150 acres, with an average rainfall of 39 in., the dam holding up a lake 0.62 miles long with a water surface of 12 acres, containing 67 million gallons of very good water. The trees, stumps, scrub, and undergrowth were cleared from the site of the reservoir and the whole surface left bare to half a chain beyond the top water level, so that on the reservoir filling no trouble was met with from discoloration or decaying vegetable matter.

The work was completed in December, 1907, and although water was stored to within 19 ft. of top water level in the following February, it was not until July, 1908, that the spillway overflowed. The wall was then reported as weeping at several of the ladder rungs and at two pin holes at the 8 ft. level, whilst a further weep was reported near the top water level which, upon inquiry, was found to have resulted from the upsetting of a bucket of soft soap, which was not washed off before the placing of the next batch of concrete. Whilst an efflorescent or deposit of lime brought out of the cement with the usual sweating is noticeable on the wall, yet the weeps have now taken up, the wall being dry with the exception of some damp patches at one or two places.

The dam was designed in the public works department of New South Wales, under the direction of the late L. A. B. Wade, M. Inst. C. E., then chief engineer for irrigation and drainage, the work being built by day labor under the supervision of Percy Allan, M. Inst. C. E., M. Am. Soc. C. E., then principal assistant engineer for water conservation. The work cost £2762, exclusive of expense involved in clearing the site of the reservoir, costs of preliminary investigation, survey, supervision and engineering expenses.

A tax on receipts of gas and electric companies that had been imposed by a Portland, Ore., ordinance has been declared void by the Oregon Supreme Court. Justice Harris, in his opinion, pointed out that the ordinance could not be upheld, as a tax on property, because the city cannot levy a property tax for general purposes except on the property and as pointed out by the general laws.

The actual performance method of appraisal, as adopted by the Washington Public Utilities Commission in evaluating the Pacific Telephone & Telegraph Company's property in that state for rate making purposes, showed a value of $19,328,209, as compared with $26,892,700 total "reproduction cost," including the development cost. This figure will be used as a base in fixing telephone rates in the state.

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Uses of a Display Room

The reason for devoting the prominent position in this issue accorded the article on "Developing Electric Range and Heating Business" is because of the importance of this new class of business as a source of central station income, because of the new ideas presented in the paper, and furthermore because it illustrates a recent departure in public utility practice. This display room is not, or at least should not be, a salesroom for electric ranges. Yet it is, and should be, a salesroom for electric service.

An important feature of public utility service is the instruction given to consumers as to how best to utilize available facilities. Electric companies, in particular, have always displayed a broad spirit in this regard. They have gone to considerable expense to explain the use of more economical lamps, even though their revenue would for a time be thus reduced. They send expert advisers to homes and business houses to tell patrons how to improve the results they are obtaining from the use of electricity. And in this instance, one company has gone to the expense of fitting up beautiful display rooms where the prospective electric cooking consumer can conveniently ask questions, receive instruction and compare equipment. Such a feature of electric service makes for better cooking, better digestion and better tempers in the home. It should tend to popularize the electrical ways of doing things and bring about a better and more friendly feeling between the public service company and the public served.

Futility of Illegal Utility Contracts

Although discriminatory rates are not legally permissible, an occasional consumer, having secured an unfair rate advantage, fails to appreciate that his "contract" affords no protection under the law. The purpose of a contract is to protect the parties thereto. But, as it is inconceivable that the law should permit that which it prohibits, transactions violating the law cannot be made the basis of contract. A contract contravening a statute is as unenforcable as one secured under duress. Participation in the unlawful intent is illegal and not only voids the contract but forfeits the protection which the courts would otherwise afford.

Laws enacted to prevent rate discrimination prescribe a rule of conduct calculated to prevent selfish persons from sacrificing the public good to personal gain. If contracts ignore this principle, the law protects neither party and even adds drastic penalties. Consequently both a public utility and its consumers are "playing safe" only when the rates for service are in accord with those regularly made. It is questionable whether the courts would compel a utility to execute or pay damages for non-execution of any other kind of rate "contract," nor would the courts be likely to compel consumers to pay delinquent bills or make good any other breach of such a contract.

Yet this does not necessarily mean that the consumer would thus escape paying the legal rate. Although the utility could not compel payment, the regulating commission would probably prevent the consumer from enjoying an unfair rate advantage.

Under the subject of contracts, also, it is of value to add that the California Railroad Commission has decided that a public utility may not require a consumer to sign a contract as a condition precedent to service, though it may require a written application for service.

Humanizing Science

Nearly a century has elapsed since Ralph Waldo Emerson, among others, gave warning that science needed to be humanized. Since that time, the tendency of education has been toward vocational training, material success and increased efficiency. This culminated, perhaps, in a remarkable classification of the principles of scientific efficiency by Harrington Emerson, among others. Herein the individual is urged to establish standards, keep records, plan his work, schedule his time and materials, and aim for dispatch. In this way it is possible to develop a man-machine capable of undreamed of accomplishments.

The more wide-spread becomes the knowledge and the application of these principles, the more rapid will be the progress of material civilization. They are in every way commendable as a means for enabling men to do more things in less time. But they have one flaw—they do not teach whether those things are really worth doing.

Most engineers, scientists, business men and efficiency experts will regard this criticism as rank heresy to the existing order of things. With every thought focused on doing more work more rapidly, with every nerve and sinew strained to increase production and develop natural resources, in brief to earn a living, the question of the "worth-whileness" of all this frantic effort never enters their heads.

The intense activity in breaking down the barriers of nature is a reaction against a former period when men did not give enough attention to the problem of making a living and when too much interest was taken in the humanities. As engineering represents the utilization of the powers of nature, the engineer has been the pioneer in the revolt against the humanities, the classics, which, while well adapted to training the true man, are not fitted to perfecting an efficient man-machine.

The natural consequence of intense specialization, which is essential to success in science, is narrowness, one-sidedness and intolerance. So the engineer, as an applied scientist, needs some broadening influence, something that will develop the remaining sides of his triune nature, some means of acquiring a deeper human sympathy.

This something is the crystallized thoughts of men, the classics, which have continued to live for centuries after men's engineering structures have failed to withstand the onslaughts of nature. And the engineer, as the pioneer in showing people how to solve the material problems, can well afford to aid in the solution of the complexities of human relationships which now threaten to destroy much of our machine-made civilization, labor troubles, class hatred, and international warfare.

The engineer's first reply to this suggestion, delivered with all the effect of an ultimatum, is "I haven't the time." Think of such an excuse from the men who have increased the effective time of life manyfold, by annihilating distance with modern means of communication, by eliminating the sources of disease with proper sanitation, and by turning night into day with electricity. Neither does the business man, the commercializing scientist, whose time has been saved by all these means, devote any more of this surplus time to nobler pursuits. "We don't know we are going, but we are on our way."

By reading of and profiting from the experience of others, a man may save himself many a bitter experience; by studying the relative values of life in their proper proportion, he develops judgment in human affairs; and by learning of past achievements he broadens his mind and acquires due modesty—all qualities in which the engineer has frequently been accused of being deficient. We do not here suggest the addition of general literature, history and political economy to an already overcrowded college curriculum, but most earnestly urge that they be carefully studied during a course of outside reading which should be continued through life.

The average engineer needs to realize that he is merely a man with a trade. Because of his education or rather lack of education, he is seldom a public spirited citizen, nor does he possess a broad view of things in their right proportions. He has ignored the psychology of salesmanship and advertising, he has disdained influencing crowds, and consequently he is in danger of being ignored and disdained by the crowd unless he takes a more active part in crowd activities.

Humanistic studies are a necessary means of acquiring a humanistic attitude of mind and counteract the evil of a training too exclusively scientific. The baby with his mechanical toys in the nursery, the boy with his science and mathematics in the school and the man with his machines in the factory, cannot develop a proper sense of human proportion nor discriminate as to standards of worth. Herein lies the value of literature properly correlated with science.

So let the scientist, the specializing engineer and the commercializing business man, humanize his science. Let men say amen to the pure amenities of life, let them cease to be the mere instrument of the wonderful machines they have created and let them learn to live their lives as it was purposed that life should be lived.

PERSONALS

A. F. Lloyd, salesman, Baker-Smith Company, is now in the Northwest on business.

E. W. Davies, of the Usona Manufacturing Company, is preparing for a business trip to the Northwest.

George C. Bowen has been made assistant sales manager of the Northwestern Electric Company at Portland.

T. H. Nelmes, salesman with Pacific States Electric Company, has returned from a short trip to Los Angeles.

Walter S. Levin, manager of the Railway Signal Apparatus Company of San Francisco is at Oroville this week.

F. W. Balaiche, electrical dealer of Vallejo, has returned to his city after a few days of business in San Francisco.

W. A. Ough, superintendent Plumas Light & Power Company, at Greenville, Cal., was at San Francisco this week.

W. D. Thomas, salesman of the Electric Railway & Manufacturers Supply Company, is in the San Joaquin Valley on business.

R. H. Coyne, Pacific Coast manager of the Kellogg Switchboard & Supply Company, is in Southern California on a business trip.

R. Kahn, salesman, Electric Railway and Manufacturers Supply Company, is making a business trip through Northern California.

S. P. Russell, manager of the electrical department of the H. W. Johns-Manville Company's San Francisco office, is at Los Angeles.

R. Popper, of the Interstate Electric Novelty Company, has returned to San Francisco from a business trip throughout Northern California.

Ely Hutchinson, hydraulic engineer with Pelton Water Wheel Company, is making a trip to Los Angeles, San Diego and the San Joaquin Valley.

M. A. Bryte, Pacific Coast agent of the Franco Battery & Carbon Company, has returned to San Francisco from a trip through Central California.

R. F. Oakes, president of the American Ever Ready Company of the National Carbon Company, has returned to San Francisco from a visit to the East.

A. F. Brown, salesman, Gamewell Fire Alarm Company, at San Francisco, is back from Arizona and New Mexico, where he has been for the last six weeks.

Nicholas Abrams, formerly with the Interstate Electric Novelty Company, is now in business for himself in the Western Agencies Company of San Francisco.

J. C. Nowell, general manager, and **H. D. Pillsbury,** vice-president of the Pacific Tel. & Tel. Company, have returned from the Northwest, after looking into the telephone interests of that territory

C. E. Hearn, who has been acting as crew manager of the appliance campaign, is back in the office of the Electric Appliance Company and has taken his old position as manager of the specialties department.

H. F. Yost has been appointed assistant manager of the San Francisco office of the Trumbull Electric Manufacturing Company. Mr. Yost was formerly in the sales department of the Electric Appliance Company of San Francisco.

D. C. Green, manager of the Salt Lake division of the Utah Power & Light Company, Salt Lake City, is attending the National Conservation Congress at Washington, D. C., which convened May 2, 3 and 4. While in the East he will spend sometime at the New York office of the Electric Bond & Share Company, and will later attend the N. E. L. A. convention at Chicago, May 22 to 26. Before returning to Salt Lake City he will spend a week at Indianapolis.

MEETING NOTICES.

Portland Sections of A. I. E. E. and N. E. L. A.

A. C. MacMicken was chairman of the April 27th meeting and the program consisted of talks on the "clean-up" campaign to be begun in Portland in May. The speakers were Jacob Kanzler, Fire Chief Dowell, Association Chief Holden, both of the Portland Fire Department, and Fire Marshal J. Stephens of Portland. Attendance 30.

Great Western Power N. E. L. A. Company Section.

Speakers for the meeting on Monday, May 8th, will be Chas. E. Mynard, assistant treasurer of the Great Western Power Company, who will speak on "Credits," and Russell D. Holabird, who will explain why the central station is giving six times as much light for $1 as was given fifteen years ago while the price of raw material and labor has advanced 100 per cent. Mr. Holabird's subject will be: "Does the Public Comprehend that Central Station is Selling Service, Not a Commodity?" Approximately 150 well-known electrical men have joined the Bay Section, among whom are the employees of the Great Western Power Company, City Electric Company, United Light & Power Company and Consolidated Electric Company.

Electrical Development and Jovian League of San Francisco.

The luncheon of April 26th was devoted solely to the consideration of business matters. After an extended discussion a new constitution and by-laws was adopted. This makes provision for the more active participation of Jovians in league affairs, provides means for the election of tribunes and the conducting of rejuvenations under league auspices. The report of the secretary-treasurer showed the finances to be in a healthy condition. In the evening about forty members were the guests of the Coast Artillery Corps in an inspection at the armory. Great interest was manifested in the capable manner in which the men handled the 10 in. disappearing rifle and the 12 in. mortar. The remarkably complete electrical equipment of the armory excited great interest.

San Francisco Engineers Discuss Military Preparedness.

A joint meeting of the San Francisco sections of the American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, American Society of Civil Engineers, and American Chemical Society, was held in Native Sons' Hall, Tuesday, evening, May 2, 1916. Papers presented included "Methods by Which the Civilian Engineers Can Prepare Themselves to Assist the Engineer Corps of the U. S. Army in Case of War," by Capt. Richard Park, Engineer Corps, U. S. A.; "The Work at the Military Training Camps," by Capt. John Murphy, Coast Artillery, U. S. A. (Captain Murphy is the officer in charge of the Military Training Camp to be held at Monterey, Cal., July 10 to August 5, 1916.) An outline of the Work of the Organization for Industrial Preparedness of the Naval Consulting Board, by A. H. Babcock, member of the Naval Consulting Board.

Oregon Society of Engineers.

The regular monthly meeting was held Friday evening, April 28th at Portland, thirty-five engineering students of the Oregon Agricultural College of Corvallis, Oregon, also being in attendance. President W. S. Turner presided. He called attention to the bill now pending in congress for the establishment of engineering experiment stations at Land Grant colleges throughout the United States, and a motion was made and passed "that the president and executive committee arrange to use the good offices of the society to aid in the passage of this bill."

A report was then read from O. Laurgaard, the society's representative to the National Irrigation Congress, held at Washington, D. C.

Dr. W. J. Kerr, president Oregon Agricultural College, made an address in which he discussed the engineering work of the college and its relation to the engineering work of

the state. He said in part: That the college always welcomed the co-operation of the Oregon Society of Engineers and desired to shape their courses so that they prepared the students as well as possible for their life's work. He reviewed the history of engineering courses in the colleges of the United States, pointing out in 1802 two men graduated without degrees in civil engineering from the United States Military Academy. In the following twenty-five years, 50 students were graduated in the United States from engineering courses. In 1840 Van Renesiar Institute conferred the first degree for engineering. In 1868 the first degree was conferred for mechanical engineering. In 1880 Stevens Institute conferred the first degree for electrical engineering. It can thus be seen that engineering as a profession for which a degree as such has been given, is of very recent date.

Messrs. Pater, Newell and Weber of the society discussed the subject in a general way, offering suggestions for improving engineering courses in order that the student would be better prepared for his life work. The concensus of opinion being that engineers needed more training along the lines of English, business, oratory and law, in order to equip them so that they will be able to express themselves orally and in their written reports, in a creditable manner.

San Francisco Electrical Contractors.

The regular monthly meeting of the California Electrical Contractors and Dealers was held at San Francisco April 27th. The chief topic of discussion was improving the appearance of retail stores and making better window displays, M. L. Scobey opening the discussion. C. C. Hillis suggested the value of good lighting in this respect. He also advised the contractor and dealer to sell on the basis of the market at the time of sale and not on what they may have paid for stock. This latter idea was emphasized by W. S. Berry and C. E. Wiggin.

S. V. Walton announced that the Pacific Gas & Electric Company's co-operative campaign with the jobbers would cease on May 1, so as to give the dealers a greater opportunity to do business. He spoke at length on the desire of his company to assist the dealer in every way possible.

Frank Somes gave specific examples of successful window displays.

W. L. Goodwin prophesied good times for the electrical contractor and dealer during the next two years. He urged that the contractors watch their costs more closely. He bespoke a greater interest in association activities, particularly as regards central station support.

The meeting was closed with a brilliant and effective talk on the value of the association as a means of self-preservation by Albert H. Elliot.

Los Angeles Jovian League.

Wednesday, April 26th, was celebrated by the League as Efficiency Day—at least the character of the program would indicate that such was the intention. C. B. Hall, secretary and treasurer of the Illinois Electric Company, had charge of the proceedings as chairman of the day, and furnished a well balanced and interesting entertainment. President Holland who has been away for several weeks, opened the meeting with a few remarks, and was heartily welcomed. A rapid fire of rather heated conversation followed an attempt to fine J. Harry Pieper, who was alleged to have exceeded his authority as acting chairman at the last meeting, when donations were received or rather taken from members to cover program expense. With his characteristic ready wit, he not only established his authority, but created considerable merriment with snappy repartee, which, while ostensibly extemporaneous, savored somewhat of collusion. After the fine had been rescinded and quiet was restored, the speaker of the day, Jesse D. Burks, was introduced. Holding the unique position of Efficiency Director of the City of Los Angeles, he is familiar with civic affairs and the work of the various departments of the municipality, and his talk was very interesting and instructive. His theme was "Business Methods in Public Business." A musical program consisting of vocal solos by Ramona Rollins Wylie, soprano, and selections by the Jovian Singers, completed the program.

TRADE NOTES.

The Electric Agencies Company, Inc., announce their removal to 419-421 East Third street, Los Angeles, where they will maintain their offices and warehouse.

W. R. Hendrey Company announce their removal from the Armour building to 313 and 313A Hoge building, corner Second avenue and Cherry street, Seattle, Wash.

NEWS OF ARIZONA CORPORATION COMMISSION.

In the case of alleged improper toll and local exchange rates charged to the Industrial School at Fort Grant the commission ruled that all calls originating and destinating in the same zone shall be included in the local exchange rate effective for that zone, and that so long as the company's rules are such as to permit one subscriber to pay rates in more than one zone, said subscriber shall have unlimited service both inbound and outbound in those zones for which he pays.

The commission has indefinitely suspended the new schedule of rates of the Arizona, California and Nevada Telephone Company for Kingman, Ariz., pending a complete investigation.

The Arizona Power Company has been hereby authorized to issue $30,000 of its first mortgage bonds for the use and benefit of the treasury of the company, and not less than 90 per cent of face value thereof, said bonds are a part of the first mortgage 6 per cent twenty-five year gold bonds of the Arizona Power Company, mortgaged under date of May 1, 1908, to the New York Trust Company, as trustee of which the total issue $2,000,000, and of which $1,892,000 are now outstanding. The maturity date of the said bonds is May 1, 1933.

The Winslow Gas, Light & Heat Company has been granted a certificate of convenience and necessity for the construction of a gas plant at Winslow, Ariz., and the certificate of the Winslow Gas Company, which has no franchise rights, has been cancelled.

The commission has issued its third annual report for the period July 1, 1914, to June 30, 1915.

INDUSTRIAL DEATHS REDUCED.

The Industrial Accident Commission has just issued figures giving the number of deaths in the industries of California during the year 1915 and draws attention to the list as compared with the statistics for 1914. In the latter year there were 691 workers killed and in 1915 533 workers gave their lives to the industries of this State. The following table shows the reductions in the death list by occupations (the word "service" includes employees of men in the professions, as well as those engaged in hotel service, apartment houses, restaurants, domestic servants and amusement or entertainment employees):

	1915	1914
Agriculture	55	62
Construction	78	115
Extraction (Mining and Quarrying)	71	86
Manufacturing	99	121
Service	25	24
Trades	20	24
Transportation and Public Utilities	172	239
Unknown	13	20
Total	533	691

NEW CATALOGUES.

The Holtzer-Cabot Electric Company has issued a neat pamphlet tracing the progress of the company for 40 years, from 1875 to 1916.

Presto Electric Heating Appliances are illustrated and described in Catalogue No. 3 from Presto Electrical Manufacturing Company of San Francisco.

ELECTRICAL LEAGUE BASEBALL AT SAN FRANCISCO.

On Saturday, April 29th, the teams of the Electrical League met for their second Saturday battle. After a few more games the boys will be playing real baseball. The Ermsco girls are about the only rooters that have shown up in a bunch, and it is very evident that the members of the organization do not realize that their teams need their support, and if they would turn out and root for their teams, they would sure see "some" games. All three games of the league will be played on the Ocean Shore Park, at Twelfth and Mission, next Saturday, May 6th, and there are plenty of benches there for everybody, so come out and root for your team.

Electric Railway & Manufacturers Supply Company vs. Westinghouse Electric & Manufacturing Company.

The Ermsco boys bit the dust by a score of 12 to 4 at the hands of their old enemy, the Westinghouse bunch. The day was perfect, with no wind and a very fast field, but on account of numerous errors made by the Ermsco boys, the game was a little one-sided. The first inning marked a one, two, three putout for both sides, but in the first of the second the Westinghouse boys took advantage of the errors made by the Ermsco and scored five runs. No more runs were made on either side until the fifth inning, when Westinghouse brought in four more and Ermsco one. In the sixth Westinghouse made two more and Ermsco tried hard to catch up, but only succeeded in bringing in three runs. Westinghouse made one more run in the seventh, which made them 12. The Ermsco boys failed to connect, which left them at the little end of the score, with only four runs to their credit. The game was called at the end of the seventh in order that the Appliance and G. E. could have their game before dark.

Electric Appliance Company vs. General Electric Company.

Three cheers for Tommy Morgan and his bunch. Appliance beat G. E. to the tune of 12 to 3, due mostly to the very good work of Pitcher Long of the Appliance and the good support he received from his team mates.

The game was a very good one from start to finish, all the boys playing for all they had in them. The field was fast and few errors were made by either team, although the G. E. boys were not playing up to form and made a few more than usual.

The first two innings looked as though the game was going to be short and sweet, both teams putting out the first three men up. In the second half of the third the G. E. boys landed on a couple that brought in two runs for them, and in the first of the fourth the Appliance boys came right back at them and landed on the ball for three counts. The G. E. boys failed to connect in their half of the fourth, which left the score 3 to 2 in Appliance favor. In the fifth the Appliance boys succeeded in bringing five more of their boys over the rubber, while G. E. was only able to bring in one. All the boys on both sides tightened up in the sixth and neither side scored. In the seventh Appliance gave their boys another shot of hop and pulled in four more. G. E. tried hard to bring up their end of the score in the seventh, and while Tallent got a hit, the next three men up were put out, so he was left on base. This made the score 12 to 3 in favor of the Appliance boys. The game was called at the end of the seventh, as it was getting late.

Pacific States Electric Co. vs. Western Electric Co.

The Pacific States Electric Company upheld its title as league leaders, by dealing a defeat of 12 to 4 to the fast Western Electric team. The "States" heavy hitting, coupled with the Western's ragged fielding, gave the winners the best of the battle throughout. Steffens, the Western twirler, was hit rather freely, while O'Connell kept his hits well scattered, but several times during the contest the Western boys filled up the bases, either by walks, or through errors, and in each case O'Connell proved himself master, either by striking out the next batter, or letting an easy tap to the infield for the third out. Another striking feature of the game was the playing of Kennedy, the "States" second baseman. Besides handling several difficult chances without an error, he found Steffens for two doubles, two singles and a walk in five trips to the plate. Dunning, the shortstop for the "States" boys, also starred, scoring three runs and figuring in two double plays. The work of this lad has been one of the sensations of the league. He covers a world of territory in the short field, and has proved himself an excellent lead-off man. The team as a whole has played great ball, always coming through when hits meant runs, and fielding well up to standard.

NEWS OF CALIFORNIA RAILROAD COMMISSION.

The Clear Lake Suspended Monorail Company has applied to the commission for authority to engage in the business of operating a monorail transportation line twenty-four miles long, between Hopland, Mendocino county, and Lakeport, Lake county, via Kelseyville. The company is incorporated for $50,000, of which $26,400 has been subscribed.

The commission has issued an order authorizing the Southwestern Home Telephone Company of Redlands, San Bernardino county, to issue $90,550 face value of promissory notes, and to use proceeds in refunding existing indebtedness. The company was also authorized to pledge $155,000 face value 5 per cent bonds, and $19,500 face value Redlands Home Telephone & Telegraph Company 5 per cent bonds as security for the notes.

The Clear Lake Railroad Company and the Clear Lake Suspended Monorail Company have filed with the Railroad Commission an application for an order authorizing the railroad company to sell to the monorail company all its property, for the purchaser to issue $50,000 of capital stock, and $900,000 of 40 year 6 per cent participating gold bonds secured by a deed of trust.

The Modesto Interurban Railway Company has filed with the commission an application for authority to borrow from the Union Savings Bank of Modesto $4,000 on a promissory note at not more than 8 per cent, and to mortgage its property to secure this, and to issue a note for $8,423.32 to T. K. Beard on account of money advanced the company in the sum of $12,423.32.

Edward Cowdery, Charles Dickey and F. R. Bain, a committee formed to acquire the properties of the Southern Counties Gas Company of California, Long Beach Consolidated Gas Company, and gas properties of the Southern California Edison Company, with the exception of its Santa Barbara plant, have applied to the commission for authority to sell said property to a new corporation to be known as the Peoples Gas Company of California in exchange for $2,750,000 par value first mortgage bonds, $650,000 par value 6 per cent debentures and $2,000,000 par value common stock.

PREPARATIONS FOR N. E. L. A. CONVENTION.

The thirty-ninth convention of the National Electric Light Association will be held in the Auditorium and Congress Hotels, Chicago, on May 22 to 26, inclusive. Prospects for the most successful convention in the history of the association are very bright indeed. Chairman E. A. Edkins of the hotel committee (72 West Adams street, Chicago), reports that upwards of 500 advance registrations have already been received.

T. C. Martin, secretary of the National Electric Light Association, 29 West Thirty-ninth street, New York, has issued the tentative program of papers for the Chicago convention in the April Bulletin of the association. There will be working sessions on Tuesday, Wednesday, Thursday and Friday of convention week. The committee reports and papers presented at the annual conventions of the N. E. L. A. are of the highest value to the electric service industry.

NEWS NOTES

INCORPORATIONS.

HANFORD, CAL.—Corcoran Telephone Company, $10,000, shares $100 each, subscribed $300, by W. Cromlie, Delia Edenloff and Paul Drullard.

RENO, NEV.—Union Gas & Electric Company, $15,000, subscribed $1000, by G. L. Fish of San Francisco, E. R. Dodge and J. R. Harrison of Reno.

PORTLAND, ORE.—The Pacific Chemical Company has been formed with a capitalization of $300,000 by C. A. Sheppard, Geo. Lovejoy and Frank E. Smith to take over the forty-year lease on Sumner and Albert Lakes held by Jason C. Moore.

CHANDLER, ARIZ.—The city water works, which has been operated by the Chandler Improvement Company has been taken over by the Chandler Water & Power Company, a corporation which has been organized with a capital stock of $100,000. The incorporators are A. J. Chandler, W. H. Robinson, Ernest J. Koch.

FARMINGTON, N. M.—The Water Ladder Irrigation Company has incorporated with a capital stock of $300,000. It will manufacture pumps in addition to engaging in general irrigation operations. The incorporators are Thomas S. Loftus and Volnoy Ervin of Farmington; Chas. R. Stedman, Augustin Morrell and Fred E. Coe of Denver.

PHOENIX, ARIZ.—Articles of incorporation of the Winslow Gas Light & Heat Company have been filed. The company proposes to operate plants for the generation of electricity, oil refineries and gas plants, and to manufacture and deal in electrical and gas contrivances, and to supply gas, oil and electric lighting, etc. The capital is $100,000. The officers are I. J. Lipsohn, president; H. M. Harrison, vice president; M. A. Pickott, secretary and treasury.

ILLUMINATION.

SEAL BEACH, CAL.—Poles for street lighting are being set and the lighting system will be ready within thirty days.

SNOHOMISH, WASH.—Councilman Stevens has proposed that the city ascertain the cost of building its own light plant.

SANTA ROSA, N. M.—A company is being organized here for the purpose of installing an electric light plant. The chief stockholders are C. R. Jones, J. J. Moise and J. A. Ruane

HUGHSON, CAL.—The board of supervisors will receive bids up to May 9th for furnishing the necessary lamps, appliances and electricity for lighting streets in the Hughson Lighting District.

SACRAMENTO, CAL.—Improvement leaders in Oak Park plan to revive the scheme to have electroliers similar to those in use on the main thoroughfares up town, installed along Thirty-fifth street and Sacramento avenue.

SUNNYSIDE, WASH.—For the purpose of making extensions of its lighting system near Sunnyside the Pacific Power & Light Company has made application to the Yakima county commissioners for a 50 year franchise over county roads.

POMONA, CAL.—The city council has passed a resolution declaring intention to improve certain portions of Alvarado street, Columbia avenue and certain other streets, by the installation of posts, wires, etc., for lighting them with electricity.

TRANSMISSION.

EVERETT, WASH.—The city has entered into an agreement with Robert Howes of Seattle to gather data on the power possibilities in Pultan Basin.

SPOKANE, WASH.—The Granby Consolidated Mining, Smelting & Power Company is preparing to construct an auxiliary station at its Hidden Creek properties that will increase the capacity about 7000 or 8000 h.p.

MYRTLE CREEK, ORE.—Engineer M. B. Germond of Roseburg has made his report on the proposed municipal power plant proposition. The site chosen involves the construction of a concrete dam in the Umpqua approximately 240 ft. long, a wooden flume 3200 ft. long and a power house at the end of the canal. The plant would develop from 200 to 300 h.p. The estimated cost is $29,094.35.

SEASIDE, ORE.—Negotiations soon will be closed by the Pacific Power & Light Company for the purchase of the Seaside Light & Power Company's property in Clatsop County. The Seaside Company operates a small steam generating plant and electric distributing system and also a telephone exchange. William Pollman, of Baker, is president and F. E. Keys, local manager.

TRANSPORTATION.

CALDWELL, IDAHO.—The proposed electrification of the Oregon Short Line Railroad to Wilder by the Caldwell Traction Company will be consummated within a short time.

VISALIA, CAL.—The Visalia Electric will extend its tracks from their present stopping point, half mile below Terminus, to Point of Rocks, according to Superintendent W. P. Ballard, who has been notified that an appropriation for this work had been granted.

STOCKTON, CAL.—The Stockton Electric Railroad Company has opened negotiations for the sale of the company's properties to the city. General Manager F. W. Webster says that high taxes and increased costs consumed the profits. The company wants to sell outright.

FRESNO, CAL.—While no definite date has been announced, it is expected that laying of rails on the Fresno Interurban Railway Company's extension from the Barton vineyard to Kutner Colony will start within a month. About five of the eight miles of grading work has been completed. It is the intention to extend the line into the Centerville and Kings River country and later build the main line from a point the other side of the Barton vineyard to Clovis.

TELEPHONE AND TELEGRAPH.

NAPA, CAL.—Sealed bids will be received up to May 10th for a telephone franchise over public highways in Napa county, as applied for by Dr. Benjamin Stetson.

HERMOSA BEACH, CAL.—The Pacific Telephone & Telegraph Company was the only bidder for a telephone franchise here and it was awarded the franchise.

YREKA, CAL.—The Klamath Telephone & Telegraph Company, owned by Hessig Bros. of Beswick, has sold out to the Siskiyou Telephone Company of Etna Mills.

TEKOA, WASH.—Negotiations are under way for the construction of 20 miles of telephone line taking in Teusot and the Indian Creek territory of the Coeur d'Alene reservation.

SAN DIEGO, CAL.—The Mexican Federal telephone line being built between Tia Juana and Ensenada by Governor Cantu is nearly completed, according to David Goldbaum, who has charge of the work.

OKANOGAN, WASH.—A franchise has been granted to the Happy Hill Telephone Company to construct telephone lines along the public highways of Okanogan county. The Skyline Telephone Company has been granted a franchise also.

ALPHABETICAL INDEX TO ADVERTISERS

The letter and number before each name are used in the classified page following

A-1 American Ever-Ready Works of National Carbon Co.. Los Angeles; 755 Folsom St., San Francisco; Seattle.

A-2 Atchison, Topeka & Santa Fe Railway Co..... 673 Market St., San Francisco; 1218 Broadway, Oakland.

B-1 Baker-Joslyn Company..... 5
71 New Montgomery St., San Francisco; 911 Western Ave., Seattle; 353 E. Second St., Los Angeles.

B-2 Benjamin Electric Manufacturing Co..... 590 Howard St., San Francisco.

B-5 Bridgeport Brass Co..... 4
(See Pierson, Roeding & Co.)

C-1 Century Electric Co..... 12
906 So. Hope St., Los Angeles; 56 Natoma St., San Francisco; 65 Front St., Portland, Ore.

C-3 Crocker-Wheeler Co.....
Crossley Bldg., 618 Mission St., San Francisco; 228 Central Avenue, Los Angeles.

C-4 Cutler-Hammer Manufacturing Co.....
579 Howard St., San Francisco; Morgan Bldg., Portland, Ore.; San Fernando Bldg., Los Angeles.

D-4 Davis Slate & Manufacturing Co..... 3
Chicago, Ill.

D-2 Dearborn Drug and Chemical Works..... 11
355 East Second St., Los Angeles; 301 Front St., San Francisco.

E-7 Economy Fuse & Mfg. Co..... 3
Kinzie and Orleans Sts., Chicago.

E-1 Edison Lamp Works of General Electric Co.....
Rialto Bldg., San Francisco; 724 So. Spring St., Los Angeles.

E-2 Edison Storage Battery Supply Co..... 11
441 Golden Gate Ave., San Francisco.

E-3 Electric Agencies Co.....
247 Minna Street, San Francisco; Central Building, Los Angeles.

E-6 Electric Novelty Works.....
533 Mission St., San Francisco.

E-4 Electric Storage Battery Co.....
743 Rialto Bldg., San Francisco.

E-5 Electric, Railway & Manufacturing Supply Co..... 11
34 Second St., San Francisco.

F-1 Fairbanks, Morse & Co.....
Los Angeles; Portland; 651 Mission St., San Francisco; Seattle; Spokane.

F-3 Federal Sign System (Electric).....
618 Mission St., San Francisco.

G-1 General Electric Co..... 10
724 So. Spring St., Los Angeles; Worcester Bldg., Portland; Rialto Bldg., San Francisco; Colman Bldg., Seattle; Paulsen Bldg., Spokane.

G-1 General Vehicle Co.....
1117 Van Ness Ave., San Francisco; 331 Wall St., Los Angeles; British Columbia Electric Ry., Ltd., Vancouver, B. C.

H-1 Habirshaw Wire Co.....
(See Western Electric Company.)

H-2 Hemingray Glass Co..... 11
236-240 So. Los Angeles St., Los Angeles; 345 Oak St., Portland; 807 Mission St., San Francisco.

H-5 Hunt, Mirk & Co.....
141 Second St., San Francisco.

H-7 Hurley Machine Co.....
New York and Chicago. (See Pacific States Electric Co.

I-2 Illinois Electric Co.....
261-263 So. Los Angeles St., Los Angeles.

I-3 Interstate Electric Novelty Co..... 2
111 New Montgomery St., San Francisco.

L-1 Leahy Manufacturing Co.....
Eighth and Alameda St., Los Angeles.

L-2 Locke Insulator Manufacturing Co..... 4
(See Pierson, Roeding & Co.)

M-2 McGlauflin Manufacturing Co.....
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M-4 Morse Chain Co..... 6
Monadnock Bldg., San Francisco.

M-3 Moore & Co., Charles C..... 3
Van Nuys Bldg., Los Angeles; Spalding Bldg., Portland; Kearns Bldg., Salt Lake City; Sheldon Bldg., San Francisco; Mutual Life Bldg., Seattle; Santa Rita Hotel Bldg., Tucson.

N-1 Nason & Co., R. N.....
151 Potrero Ave., San Francisco.

N-6 National Carbon Company..... 12
Cleveland, Ohio.

N-2 National Conduit & Cable Co., The.....
Trust and Savings Bldg., Los Angeles; Rialto Bldg., San Francisco.

N-3 National Lamp Works of G. E. Co.....
(All Jobbers.)

N-4 New York Insulated Wire Co..... 12
629 Howard St., San Francisco.

N-5 Northwestern Pacific Railroad.....
808 Phelan Bldg., San Francisco.

O-1 Okonite Co. (The)..... 12
(All Jobbers.)

P-1 Pacific Electric Manufacturing Co.....
80 Tehama St., San Francisco.

P-2 Pacific States Electric Co..... 2
236-240 So. Los Angeles St., Los Angeles; 61-67 Fifth St. No., Portland; 200-210 Twelfth St., Oakland; 575 Mission St., San Francisco; 307 First Ave. So., Seattle.

P-4 Pelton Water Wheel Co..... 11
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P-5 Pierson, Roeding & Co..... 4
Pacific Electric Bldg., Los Angeles; Rialto Bldg., San Francisco; Colman Bldg., Seattle.

P-7 Pittsburgh Piping & Equipment Co..... 12
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S-1 Schaw-Batcher Company, Pipe Works, The..... 4
211 J St., Sacramento; 356 Market St., San Francisco.

S-4 Southern Pacific Co..... 2
Flood Bldg., San Francisco.

S-5 Sprague Electric Works..... 3
Rialto Bldg., San Francisco; Colman Bldg., Seattle; Corporation Bldg., Los Angeles; Electric Bldg., Portland; Paulsen Bldg., Spokane.

S-6 Standard Underground Cable Co..... 3
First National Bank Bldg., San Francisco; Hibernian Bldg., Los Angeles; Yeon Bldg., Portland; Central Bldg., Seattle, Wash.

T-1 Thomas & Co., R.....
Pacific States Electric Co. and Western Electric Co., Pacific Coast Representatives.

T-2 Tubular Woven Fabric Company..... 5
Pawtucket, R I.

U-1 Union Sheet Metal Works.....
575 Howard St., San Francisco.

W-1 Wagner Electric Manufacturing Company..... 3
St. Louis, Mo.

W-2 Western Electric Co.....
Eighth and Santee Sts., Los Angeles; 1901 Telegraph Ave., Oakland, Cal.; 680 Folsom St., San Francisco; 907 First Ave., Seattle; 45 North Fifth St., Portland, Ore.

W-4 Westinghouse Electric and Manufacturing Co.....
50-52 East Broadway, Butte; Van Nuys Bldg., Los Angeles; Couch Bldg., Portland; 212 So. W. Temple, Salt Lake City; 165 Second St., San Francisco; Second and Cherry Sts., Seattle; Paulsen Bldg., Spokane.

W-5 Westinghouse Machine Co.....
141 Second St., San Francisco.

W-6 Westinghouse Lamp Co.....
(See Westinghouse Electric & Manufacturing Co.)

W-8 Western Pipe & Steel Co.....
444 Market St., San Francisco; 1758 North Broadway, Los Angeles.